

PRINCETON 2.5" LYNX² SATA III

2TB DATA SHEET

Preliminary



Features:

- SATA 3.1 Compliant,
 - SATA 6.0Gb/s with 3Gb/s and 1.5Gb/s support
- ATA modes supported
 - PIO modes 3 and 4
 - Multiword DMA modes 0, 1, 2
 - Ultra DMA modes 0, 1, 2, 3, 4, 5, 6
- ATA8-ACS2 command set support
- Industry-standard, 512-byte sector size support
- Hot-plug capable
- Native command queuing support with 32 command slot support
- RoHS-compliant package
- Temperature Management
- S.M.A.R.T. (Self-monitoring, analysis, and reporting technology)¹
- Capacities: up to 2000GB
- Performance (lifetime)²
 - Sequential READ: up to 490 MB/s @128K
 - Sequential WRITE: up to 430 MB/s @128K
 - Random READ: up to 9K IOPs @4K
 - Random WRITE: up to 23K IOPs @4K
- Endurance: Total bytes written (TBW)
 - Up to 2.8 PB
- Flash Support
 - ONFI 3.0
 - Toggle 2.0
 - 4KB, 8KB, & 16KB page size
 - 1-plane, 2-plane & 4-plane operation
- DRAM Support
 - 16-bit wide Interface

- Security
 - 256-bit AES compliant Data Encryption
 - ATA8 security feature set
 - Secure Erase
- Reliability
 - MTBF(PoH): 1.0 million device hours⁴
 - Data Shaping technique to increase endurance
 - Static and dynamic wear leveling
 - Field-upgradable firmware
 - Non-recoverable Read Errors: (Less than 1 sector per bits read) 10¹⁶
 - Low power consumption: <4W (AVE)
- Mechanical/Electrical
 - Standard SATA connector
 - 5V power (±10%)
 - 2.5-inch drive: 100. mm x 69.75mm
 - 7.0 mm thickness
 - Weight: 75g
- Environmental
 - Operating temperature: 0°C to 70°C
 - Humidity (operating): 5% to 95% RH
 - Shock and vibe
 - 1500G/0.5ms
 - 2–500Hz at 3.1G

- Notes:
1. Utility required to read SMART attributes thru RAID controller.
 2. Typical I/O performance numbers as measured using Iometer with a queue depth of 32 and write cache enabled.
 3. The product shall achieve a mean time between failure (MTBF) of 1.0 million hours, which are based on population statistics that are not relevant to individual units.
 4. 1GB = 1 billion bytes (1000⁴)

Ordering Information

Table 1 lists the ordering part number for custom PRINCETON Mobile MLC and SLC drives

Table 1 Ordering Information

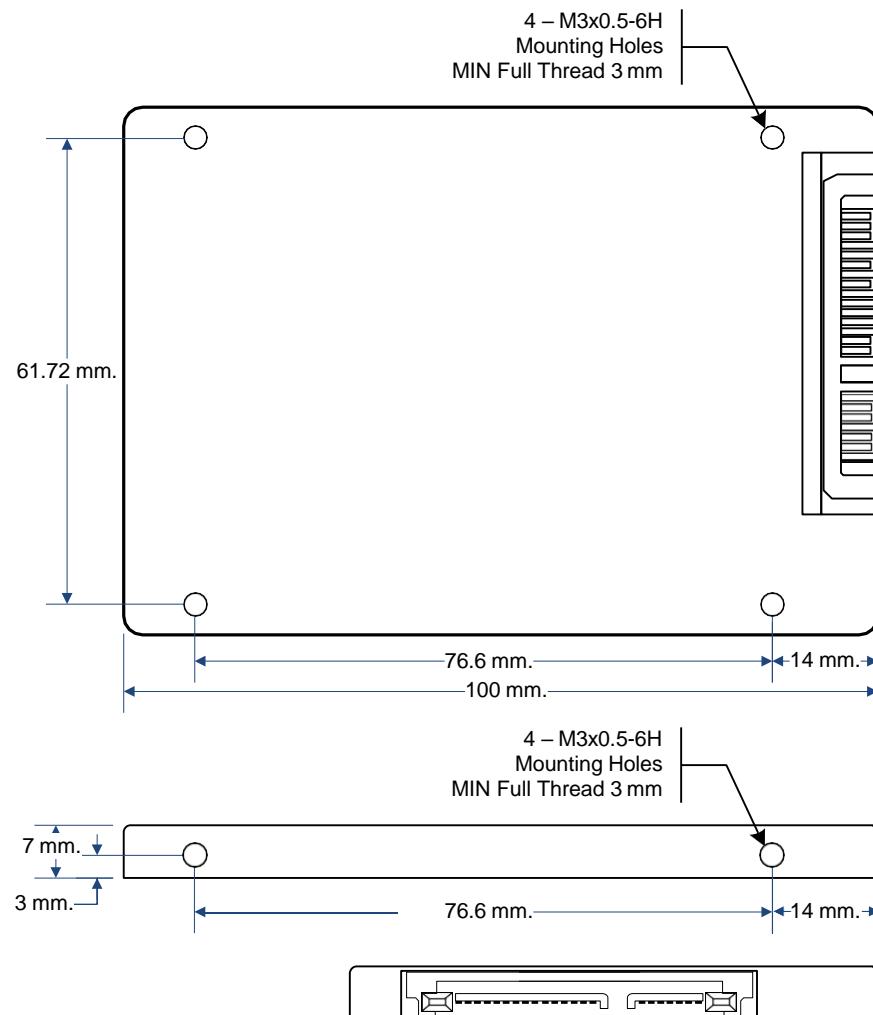
User Capacity (1000 ³)	Part Number	
2TB	SSSD002TBCSU2-E7	

General Description

PRINCETON Technology SSD is designed to bring enterprise class storage to mobile PC users. With the shift from the hard disk drive to the solid state drive the PRINCETON SSD is a drop-in replacement for the hard disk drive (HDD) or conventional Solid State Disk (SSD). It delivers superior reliability, durability, performance and power efficiency - keeping mobile PCs working reliably in the toughest of conditions.

Packaged in an industry standard 2.5" drive enclosure, the SSD integrates easily in existing storage infrastructures. The PRINCETON SSD provides high bandwidth and IOPS while efficiently managing write amplification. Employing SSD technology in a system enables faster boot times, quicker application load times, lower power consumption, and enhanced reliability.

Package Dimensions



Architecture

PRINCETON's solid state drive (SSD) employs two instances of a single-chip controller with a SATA interface connected thru a RAID controller in a RAID0 configuration.

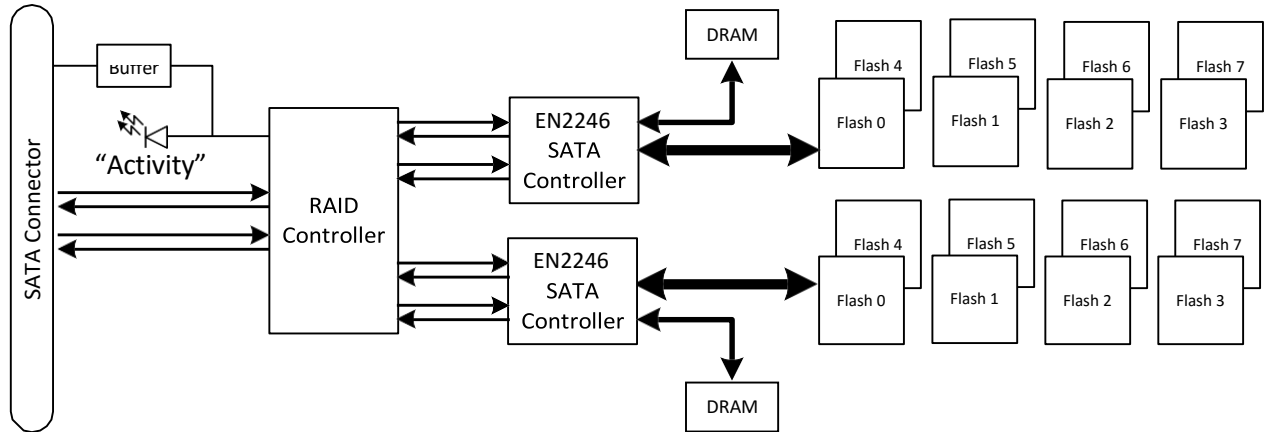


Figure 3 – Block Diagram

Logical Block Address Configuration

The drive is set to report the number of logical block addresses (LBA) that will ensure sufficient storage space for the specified density. Standard LBA settings, based on the IDEMA standard (LBA1-02), are shown below.

Capacity

The capacity is reported as a decimal count of Bytes. The capacity is determined using the industry standard method as defined by the International Drive Equipment Manufacturers Association (IDEMA).

Drive capacity is calculated with the following equation:

$$\text{SSD Capacity in Gbytes} = (\text{UserAddressableLBAcount} - 21168) / 1953504$$

Equation 1 IDEMA user capacity calculation

Table 2 PRINCETON Drive Configurations

User Capacity	Provisioning	Part number	LBA	Comments
2TB	2.4%	SSSD002TBCSU2-E7	3,907,029,168	

Performance

Table 3 PRINCETON Drive Configurations

User Capacity (1000 ³)	Sequential		Random		Access
	Read (MB/s)	Write (MB/s)	Read (IOPS)	Write (IOPS)	
2000	>490	>430	>23K	>8K	<100 μsec

Table 4 Nominal Dimensions and Weights

Signal Name	Type	Description
Height	7.0	mm
Width	69.85	mm
Length	100	mm
Unit weight	75	g

Interface Connectors

The PRINCETON SSD uses the industry standard 2.5" SATA connector as defined by SATA-IO. The pin-out of the signal segment is shown in Table 5 and the pin-out of the power segment is shown in Table 6.

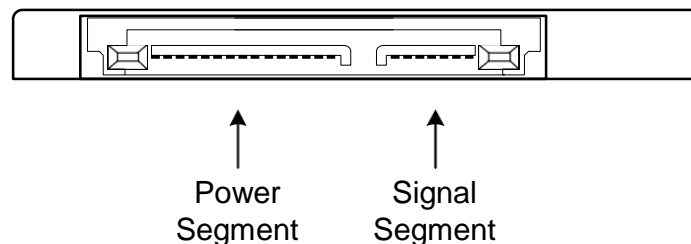


Figure 4 – SATA Connections

Table 5 Signal Segment pin assignments

Signal Name	Type	Description
S1	GND	Ground
S2	A+	A+ (transmit)
S3	A-	A- (transmit)
S4	GND	Ground
S5	B-	B- (receive)
S6	B+	B+ (receive)
S7	GND	Ground

Table 6 2.5-Inch SATA Power Segment Pin Assignments

Signal Name	Type	Description
P1	V33	No connect
P2	V33	No connect
P3	V33	No connect
P4	GND	Ground
P5	GND	Ground
P6	GND	Ground
P7	V5	5V power
P8	V5	5V power
P9	V5	5V power
P10	GND	Ground
P11	DAS	Device activity signal
P12	GND	Ground
P13	V12	No connect
P14	V12	No connect
P15	V12	No connect

Note: 1. The DAS signal may be optionally connected to GND if an LED is not being used.

Commands

Table 7 Supported ATA Command Set

Command Name	Command Code (hex)	Description
CHECK POWER MODE	0x98	
CHECK POWER MODE	0xE5	
DEVICE CONFIGURATION	0xB1	
FLUSH CACHE	0xE7	
FLUSH CACHE EXT	0xEA	
IDLE	0xE3	
IDLE	0x97	
IDLE IMMEDIATE	0x95	
IDLE IMMEDIATE	0xE1	
NOP	0x00	
READ BUFFER	0xe4	
READ BUFFER DMA	0xe9	
READ DMA	0xc8	
READ DMA EXT	0x25	
READ DMA (without retries)	0xc9	
READ FPDMA QUEUED	0x60	
READ LOG DMA EXT	0x47	
READ LOG EXT	0x2F	
READ MULTIPLE	0xc4	
READ MULTIPLE EXT	0x29	
READ NATIVE MAX ADDRESS	0xF8	

READ NATIVE MAX ADDRESS EXT	0x27	
READ SECTORS	0x20	
READ SECTORS EXT	0x24	
READ SECTORS (without retry)	0x21	
READ VERIFY SECTORS	0x40	
READ VERIFY SECTORS EXT	0x42	
READ VERIFY SECTORS (without retry)	0x41	
RECALIBRATE	0x10	
REQUEST SENSE DATA EXT	0x0B	
SECURITY DISABLE PASSWORD	0xF6	
SECURITY ERASE PREPARE	0xF3	
SECURITY ERASE UNIT	0xF4	
SECURITY FREEZE LOCK	0xF5	
SECURITY SET PASSWORD	0xF1	
SECURITY UNLOCK	0xF2	
SEEK	0x70	
SET FEATURES	0xEF	
SET MAX ADDRESS	0xF9	
SET MULTIPLE MODE	0xC6	
SET NATIVE MAX ADDRESS EXT	0x37	
SLEEP	0x99	
SLEEP	0xE6	
SMART	0xB0	
STANDBY	0xE2	
STANDBY	0x96	
STANDBY IMMEDIATE	0x94	
STANDBY IMMEDIATE	0xE0	
WRITE BUFFER	0xE8	
WRITE BUFFER DMA	0xEB	
WRITE DMA	0xCA	
WRITE DMA EXT	0x35	
WRITE DMA FUA EXT	0x3D	
WRITE DMA (without retries)	0xCB	
WRITE FPDMA QUEUED	0x61	
WRITE LOG DMA EXT	0x57	
WRITE LOG EXT	0x3F	
WRITE MULTIPLE	0xC5	
WRITE MULTIPLE EXT	0x39	
WRITE MULTIPLE FUA EXT	0xCE	
WRITE SECTORS	0x60	
WRITE SECTORS EXT	0x34	
WRITE SECTORS (without retry)	0x31	

Smart Attributes

Table 8 S.M.A.R.T Attributes

Reliability Tracking		Comments
01h	Raw Read Error Rate	
05h	Retired Block Count	
09h	Power On Hours	
0Ch	Device Power Cycle Count	
A0h	Uncorrectable Sector Count	
A1h	Number Valid Spare Blocks	
A3h	Number initial invalid blocks	
A4h	Total erase count	
A5h	Maximum Erase Count	
A6h	Minimum Erase Count	
A7h	Average Erase count	
A8 h	Max erase count of spec	
A9h	Remain Life (%)	
AFh	Program Fail Count	
B0h	Erase Fail Count in Worst Die	
B1h	Total Wear level Count	
B2h	Runtime invalid block count	
B5h	Total Program Fail Count	
B6h	Total erase fail count	
BBh	Uncorrectable Error Count	
C0h	Power-off retract count	
C2h	Temperature	
C3h	Hardware ECC Recovered	
C4h	Reallocation Event Count	
C6h	Uncorrectable Sector Count	
C7h	UltraDMA CRC Error Count	
E1h	Total LBAs Written from Host	x 32MB
E8h	Available Reserved Space	
F1h	Total LBAs Written from Host	x 32MB
F2h	Total LBAs read from Host	x 32MB

Reliability

PRINCETON's SSDs incorporate advanced technology for defect and error management. The Controller uses various combinations of redundant storage elements, hardware-based error correction algorithms and firmware-based static and dynamic wear-leveling algorithms.

Over the life of the SSD, uncorrectable errors may occur. An uncorrectable error is defined as data that is reported as successfully programmed to the SSD but when it is read out of the SSD, the data differs from what was programmed.

Table 9 Uncorrectable Bit Error Rate

Uncorrectable Bit Error Rate	Operation
<1 sector per 10 ¹⁶ bits read	Read

The product life is at least 5 years or 43,800 power-on hours, whichever comes earlier under the following conditions:

- Power-on hours = 8,760 per year
- Operating time = 100% of power-on hours
- Active/Idle duty cycle = 90% of the time
- Environmental = temperature, altitude, humidity and voltage within operating ranges
- The drive should be protected from electrostatic discharge (ESD)
- The product life does not represent any warranty or warranty period. Applicable warranty and warranty period are covered by the purchasing agreement.
- Note: Product life is defined as time in service at systems conditions while maintaining compliance to the MTTF specification for the device.

Mean Time Between Failures

Mean time between failures (MTBFs) for the SSD can be predicted based on the component reliability data using the methods referenced in the Telcordia SR-332 reliability prediction procedures for electronic equipment.

Table 10 Drive MTBFs

Density	MTBF (Operating Hours) ¹
2000	1 million

Note: 1. A mean time between failure (MTBF) of 1.0 million hours is based on population statistics that are not relevant to individual units.

Preventive Maintenance

Not Applicable. No preventative maintenance is required.

Unauthorized maintenance to the SSD will void the warranty.

Endurance

The endurance of a drive is expressed as the total bytes written (TBW). The TBW is a function of the capacity of the drive, the PE cycles of the flash devices used, the Write Amplification (WA) of the controller and the efficiency of the wear leveling algorithm.

There is a generic calculation that has been standardized by JEDEC. The industry standard equation is given in Equation 2.

$$TBW = (\text{Flash Capacity}(\text{user}) * \text{PE Cycles}) / (2 * \text{WA})$$

Where:

Flash capacity (user): Industry Standard uses the user capacity of the drive in Decimal Bytes.

PE cycles: Max # of PE cycles for Flash devices WA: Write

Amplification

Efficiency: ratio of the best case to worst case wear leveling block. Industry standard assumes the worst case is 2X the best case

Equation 2 JEDEC STD / IDEMA Total Bytes Written Calculation

Table 11 gives the life expectancy of the drive in Total Bytes Written (TBW) for the best case WA for the controller used in PRINCETON drives for a typical and a worst case WA. Actual WA for a particular application can be determined using the S.M.A.R.T. attributes.

Table 11 Drive Endurance – Total Bytes Written (TB)

User Capacity	Provisioning	Raw Flash	Standard MLC based part numbers	Write Life w/MLC	Comments
				(TB)	
2TB	2.4%	2048	SSSD002TBCSU2-E7	2794	

Electrical Characteristics

Table 12 Absolute Maximum Ratings

Condition	Symbol	Min	Max	Unit
Voltage Input	V _s	3.3	5.5	V
Operating Temperature	T _A	0	70	C
Non-operating Temperature		-40	85	C
Relative Humidity		5	95	%

Table 13 Shock and Vibration

Condition	Specification
Operating shock	1500 G / 0.5ms

Operating Vibration	2-500 Hz at 3.1G
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Table 14 Average Power

Capacity (GB)	Idle	100% Write	100% Read	Unit
2000	< .250	<1.5	<1.0	A

Compliance

PRINCETON SSDs comply with the following:

- RoHS “green”
- CE (Europe): EN55022, 2006 Class B and EN55024, 1998 + A1: 2001 + A2:2003
- FCC: CFR Title 47, Part 15, ICES-003, all Class B
- BSMI (Taiwan): approval to CNS 13438 (testing in progress)
- C-TICK (Australia, New Zealand): approval to AS/NZS CISPR22 (testing in progress)
- TUV (Germany): approval to IEC60950/EN60950 (testing in progress)
- VCCI (testing in progress)